

APRIL 2019 Update**CBRS Forecast****Major changes to the forecast this half include:**

1. The underlying assumptions around CBRS market timing have not changed much. We expect the CBRS commercialization under GAA to start in the third quarter of 2019 and the PAL auction to take place in the second half of 2020.
2. We have revised the Fixed Wireless Access (FWA) adoption of CBRS radios and customer premise equipment (CPE) upward with an expectation that many smaller WISPs in rural counties will operate under GAA even without PAL licenses.
3. The increasing certainty around SAS pricing (e.g., Google's SAS pricing of \$2.25 per subscriber) and the increasing number of CBRS radios and LTE CPE's coming to market will entice WISPs to adopt the newfound 3.5GHz spectrum and standard LTE gears to aid in their businesses. Moreover, the additional government funding source like Rural Digital Opportunity Fund will provide a tailwind to the overall FWA sector.
4. While some smaller cable operators are trialing CBRS FWA, we are expecting very moderate uptake here. If the competition between mobile/telco vs. cable in rural markets heats up, we expect the FWA uptake from cable operators may increase more significantly.
5. The increase in FWA radios for the WISP segment will predominantly be 2T2R radios as they offer lower CAPEX alternative for this price-sensitive market.
6. The Private LTE market estimate has been lowered based on a downward revision to CPE shipments in the latter part of our forecast period. This revision is based on our "bottoms-up" forecast from our recently published *Private LTE and 5G* market study.
7. We have also revised down the Enterprise FWA use case based on our *Private LTE and 5G* market study. While we do expect certain municipalities and enterprises to leverage the CBRS band for high-bandwidth applications like video surveillance, we believe this type of applications may be somewhat limited as there are other alternatives like 60GHz or microwave solutions.
8. We have brought down CPE shipment forecast for cable operators for the mobile offload use case. While we believe CBRS CPE for mobile offload can be an effective strategy for cable operators, there is a higher probability that cable operators may not pursue this strategy based on the larger macro uncertainty around T-Mobile/Sprint merger saga. If the merger falls apart (yet again), then there is a higher probability that Charter or Comcast (or JV) may pursue this path for their facilities-based mobile strategy.

9. We believe that outdoor strand and standalone indoor small cell strategy is likely a near-term pursuit for the cable operators.
10. We have revised indoor CBRS deployments by cable operators upward. We believe cable operators will pursue this strategy instead of CBRS-enabled CPEs as this provides flexibility in CBRS radio deployments at SMB locations. Decoupling CBRS and Wi-Fi capabilities at SMB locations enables flexible and cost-effective deployment strategy for the cable operators.
11. Net of above changes slightly decreases the overall number of CBRS small cell shipments in 2023. By application or use cases, the CBRS small cell shipment increases for FWA.
12. The net overall CPE shipment remains about the same with the increase of CPE shipments for FWA application offset by the decrease in CPE shipments to cable operators for mobile offload.
13. The overall CBRS market estimate in 2023 has been increased, as a bigger share of higher-priced outdoor small cells make up the shipment share. By 2023, the total CBRS Radio Equipment revenue, including small cells and CPEs, is expected to reach over \$930M. A part of the reason for the revenue gain is due to slightly upward revision to the average selling price of the outdoor and indoor gears.
14. In the near term, FWA and Private LTE applications will drive the initial market ramp. After the PAL auction (likely in the second half of 2020), the mobile and cable operators will ramp up their infrastructure deployments, or “light up” CBRS operation on gears that have already been deployed. At the end of the forecast period, the cable and mobile operators will drive the bulk of the CBRS radio equipment sales.